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Satellite tracking of narwhals (*Monodon monoceros*) from Admiralty Inlet (2009) and Eclipse Sound (2010-2011)

Surveillance par satellite des narvals (*Monodon monoceros*) de l'inlet de l'Amirauté (2009) et du détroit d'Éclipse (2010-2011)

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ABSTRACT

Seven satellite tags attached to narwhal (*Monodon monoceros*) in 2009 in Admiralty Inlet, and five and seven tags in Tremblay Sound in 2010 and 2011 respectively, provided information on movements, overwintering regions, and site fidelity within and between years. Based on past tracking studies, as well as some genetic and contaminant analyses, the narwhals from Admiralty Inlet and Eclipse Sound are considered separate summering stocks. The present study found (1) a greater degree of range overlap between Eclipse Sound and Admiralty Inlet, both within and between years, than had been documented in past studies; (2) a single narwhal overwintered in northern Foxe Basin, a region in which narwhals have rarely been known to spend the winter; and (3) a narwhal spent time in January in Disko Bay, Greenland, the first time a narwhal tagged in Canada spent time along the West Greenland coast where winter hunting occurs. These results confirm there is some spatial overlap among narwhals particularly from Admiralty Inlet and Eclipse Sound stocks outside the summer season. In addition, the Admiralty Inlet and Eclipse Sound summering aggregations had some degree of mixing during the 2011 summer season. Further tracking of narwhals from these two stocks is required to determine if the recent movements are typical of a greater proportion of the population.

RÉSUMÉ

En 2009, sept émetteurs satellites ont été fixés sur des narvals (*Monodon monoceros*) dans l'inlet de l'Amirauté, cinq sur des narvals dans le détroit d'Éclipse en 2010 et sept en 2011 à ce même endroit. Ces émetteurs ont fourni des renseignements sur les mouvements, sur les lieux d'hivernation et sur la fidélité aux sites de ces mammifères au cours d'une année, et d'année en année. Selon les études de localisation par satellite antérieures et certaines analyses génétiques et de contaminants, les narvals de l'inlet de l'Amirauté et du détroit d'Éclipse sont considérés comme étant des stocks estivants distincts. La présente étude démontre 1) qu'il y a un plus grand nombre de points communs entre l'inlet de l'Amirauté et le détroit d'Éclipse que ne l'indiquent les études antérieures, tant au cours d'une année que d'année en année, 2) qu'un seul narval a hiverné dans le nord du bassin Foxe, une région dans laquelle il est reconnu que les narvals ont rarement hiverné, et 3) qu'un narval a passé du temps en janvier dans la baie de Disko, au Groenland. Il s'agit de la première fois qu'un narval muni d'un émetteur canadien passe du temps le long de la côte ouest du Groenland pendant la chasse d'hiver. Ces résultats confirment qu'il y a un certain chevauchement spatial entre les stocks de narvals, particulièrement entre ceux de l'inlet de l'Amirauté et du détroit d'Éclipse en dehors de la saison estivale. De plus, les regroupements d'été des narvals de l'inlet de l'Amirauté et du détroit d'Éclipse se sont quelque peu mélangés durant la saison estivale de 2011. Une surveillance approfondie de ces deux stocks de narvals est nécessaire pour déterminer si les récents mouvements sont typiques d'une plus grande proportion de la population.

INTRODUCTION

Satellite tracking of animals provides information on their migratory abilities (Mansfield et al. 2009), foraging ecology (Jonsen et al. 2007), habitat use (Chilvers 2008; Cotté et al. 2009), and ecological traits (Wade et al. 2006; Andrews et al. 2008). The devices utilized for satellite telemetry can also be used to monitor changes in the organism's habitat (McCafferty et al. 1999). Satellite tracking is particularly useful for monitoring marine mammals, as they are difficult to observe in the natural environment and often make extensive migrations into remote areas. The satellite tracking devices, as well as the process of instrumenting the animals is a costly endeavour; however, for some animals it is the only feasible approach for monitoring. The narwhal (*Monodon monoceros*), in particular, spends most of the winter in heavy pack ice and in complete darkness; thus, without satellite tracking it would be impossible to monitor their position and behaviour during this time. Satellite tracking devices are also equipped with sensors for determining dive depth, water temperature, salinity, and other environmental features.

Current knowledge from satellite tracking has provided information regarding the home-range of narwhals in summer and winter locales (Heide-Jørgensen et al. 2002), migratory pathways (Dietz et al. 2001; Heide-Jørgensen et al. 2002; Heide-Jørgensen et al. 2003), diving habits (Martin et al. 1994; Heide-Jørgensen and Dietz 1995; Laidre et al. 2002, 2003, 2004; Lydersen et al. 2007), evasion behaviour (Laidre et al. 2006), and even to infer tusk growth (Heide-Jørgensen et al. 2008). There is currently a subsistent hunt of narwhals in both Canada and Greenland and one of the primary goals of satellite tracking is to determine if narwhal groups remain spatially segregated in the summer months and can therefore be considered separate management units, referred to as stocks (Dietz and Heide-Jørgensen 1995; Dietz et al. 2001; Heide-Jørgensen et al. 2002), from which hunting allocations can be determined. Previous studies have found narwhals return to the same fiords and inlets every summer (Dietz et al. 2001, Heide-Jørgensen et al. 2003, Dietz et al. 2008, M.P. Heide-Jørgensen and K. Laidre, unpubl. data), which has aided in advice on stock delineation and the determination of Total Allowable Land Catch (TALC) of narwhals for the subsistence hunt. Current knowledge on narwhal stocks in Canada suggests that the Baffin Bay narwhal population is composed of at least four narwhal summering stocks: Somerset Island (includes Prince Regent Inlet, Gulf of Boothia, and Peel Sound areas), Admiralty Inlet, Eclipse Sound, and East Baffin Island. There are also narwhals found elsewhere in the Canadian high Arctic (DFO 2010; Richard 2010) but their relationship to the four summering stocks is unknown. However, given the relatively large population of Baffin Bay narwhals (approximately 80,000 individuals (DFO 2008, 2010)), only a small proportion have been tracked (n = 67), i.e., narwhals from the Admiralty Inlet, Eclipse Sound, and Somerset Island stocks. To increase the sample size, tagging expeditions in Admiralty Inlet and Eclipse Sound were undertaken in 2009-2011 to gain a better understanding of narwhal movements in those regions. The objectives of this study were to assess the degree of site fidelity (both within and between years) of Admiralty Inlet and Eclipse Sound narwhals in the summer and to gain more data on the autumn migration routes and over wintering ranges for these narwhal stocks.

METHODS

STUDY AREAS

Narwhals were tagged at Kakiak Point (72° 41' 00" N, 86° 41' 20" W) in Admiralty Inlet near the community of Arctic Bay in August 2009, and in Tremblay Sound (72° 21' 23" N, 81° 6' 24" W) near the community of Pond Inlet in August 2010 and 2011. The high steep-sided cliffs of the Brodeur and Borden Peninsulas and Lancaster Plateau border Admiralty Inlet and Tremblay Sound respectively; however, both areas also exhibit low bluffs and raised beaches with shores of sand and gravel (Sempels 1982; Dietz et al. 2001, 2008). Tremblay Sound is a narrow inlet approximately 45 km long and up to 275 m deep (Dietz et al. 2001). Admiralty Inlet is a 250 km long fiord with maximum depth of 700 m (Dietz et al. 2008). Narwhals are known to commonly occur in these regions and have been successfully tagged in both areas in the past (Kingsley et al. 1994; Martin et al. 1994; Dietz et al. 2001, 2008).

CAPTURING AND INSTRUMENTING THE WHALES

Methods for whale capture and satellite tagging were previously developed and successfully utilized by Orr et al. (2001), Dietz et al. (2001, 2008), and Heide-Jørgensen et al. (2003, 2008). Briefly, narwhals were caught in nets set perpendicular to the shore in waters with a maximum depth of approximately 58 m. Nets were dark green or black in color with 40 cm x 40 cm mesh and 3.5-5 m deep. Nets were anchored to a large stone on shore on one end and attached to a bag of large rocks at the off shore end. Nets were kept afloat using 6-8, 30 cm white buoys that were clearly visible from shore. The nets were monitored 24 hours a day and narwhal were easily detected in the net as one or several of the buoys would be completely submerged. When this occurred, one zodiac boat with 3-4 people on board would drive out to where the buoy had gone down and pull the narwhal(s) to the surface. A second zodiac, with 3-4 passengers, would drive to the anchor line and cut the net from the anchor. The shore crew (5-6 people) would then pull the net into shore. Once close to shore, the narwhal was positioned with its tail in the shallowest water, and disentangled from the net. A looped rope with rubber coating was placed around the tail and for females, a hoop net was placed over the head or for males a rope was wrapped around the tusk and held by one or two people. Once stabilized, morphometric data such as length, fluke length, and tusk length (if applicable) were recorded. Heart rate was monitored throughout the process and blood was collected from the underside of the tail fluke, by a veterinary, at the beginning and end of the capture. The satellite tag was attached with two or three 10 mm nylon pins through the dorsal ridge.

DATA ANALYSIS

Narwhals were equipped with Wildlife Computers SPLASH tags and were programmed to transmit daily during the summer from July 1 to September 31 and subsequently on a 3-day duty cycle. The duty cycle allows for a longer deployment period, while daily transmissions provide more detailed movements of narwhals in their summering area. Data on location of all deployed tags were obtained from the ARGOS system (CLS America). ARGOS data files were extracted using WC-DAP 3.0 Build 69 software (Wildlife Computers). Movements of narwhals deployed with satellite tags in Admiralty Inlet in 2009 and Tremblay Sound in 2010 and 2011 were interpolated from the ARGOS data using Jonsen's state-space model (SSM) (Jonsen et al. 2005, 2007), implemented in R and WinBUGS code, with code modifications by Luque (2007).

Prior to running the SSM, the data were filtered to remove location quality class 'Z' which have no estimates of location precision and cannot be used by the state-space model. The SSM uses the ARGOS location precision classes to weigh the information in the raw locations during the interpolation (Jonsen et al. 2005, 2007).

The tags transmitted on different schedules depending on the month: every day between July and September and every third day between October and June. Locations are calculated at a CLS ground station based on a shift in transmission frequency (Doppler shift) of at least five transmissions received by the satellite in a single satellite pass overhead a tag. The frequency of location intervals for the daily locations had 75%, 90%, 95%, and 99% quantiles of 1.70, 2.53, 4.07, and 7.70 hours respectively. A time step of 12 h or 0.5 d (tstep = 0.5) was therefore deemed adequate to interpolate the daily locations using Jonsen's SSM. Duty-cycled movement was interpolated using a time step of 3 d (tstep = 3).

Interpolated narwhal locations were then entered into ESRI's ArcView 3.3, and maps were generated using a polar stereographic projection with central meridian 75°W and reference latitude 65°N.

RESULTS

Eight narwhals were tagged in Admiralty Inlet in 2009 (five males and three females); five were tagged in Tremblay Sound in 2010 and seven, again in Tremblay Sound, in 2011 (total = four males and 10 females) (Table 1). Tagged whales ranged in length from 3.07 m to 4.61 m. Of the eight Admiralty Inlet animals, male #39312 was taken by a local hunter the day after it was tagged, so no information was collected from that animal. Four narwhals (females #39249, #39290, #39313, and male #39309) remained in Admiralty Inlet until September 18, after which they all travelled to Prince Regent Inlet on September 19 (Figures 1 and 2; Table 2A). Female #39249 and male #39309 left Prince Regent Inlet and entered Lancaster Sound on September 30; female #39313 returned to Lancaster Sound on October 10. In contrast, female #39290 went southeast, crossing Fury and Hecla Strait on October 30 into northern Foxe Basin where it remained until its tag stopped providing locations on February 22, 2010 (Figure 2; Tables 1 and 2A). Male #39287 left Admiralty Inlet on September 18 and remained at the mouth of Prince Regent Inlet for a short time before heading east through Lancaster Sound and southeast towards Davis Strait (Figure 1). Male #39256 left Admiralty Inlet on September 18 and headed through Lancaster Sound to the mouth of Prince Regent Inlet but did not enter the inlet. It instead turned east on October 6 moving out of Lancaster Sound and then southeast towards Davis Strait (Figure 1). The last male (#39311) did not leave Admiralty Inlet until October 6 when it headed southeast to Davis Strait (Figures 1 and 2). All the narwhals that migrated to Davis Strait remained there for the winter, in an area northeast of Broughton Island. Tag #39287, #39311, and #39256 were transmitting by spring (April 15-July 31) and these whales were still located in northern Davis Strait until their tags quit on June 2, 3, and 23, respectively (Figure 2; Table 2A).

The five 2010 Tremblay Sound narwhals remained in the Eclipse Sound area until September 20 when the two males (#51871 and #51872), that had been tagged together, traveled out of the Sound and southeast along Baffin Island into Buchan Gulf (Figure 3). The two males continued traveling southeast in October past Qikiqtarjuaq. These two whales had very similar movement patterns, visited the same locations at the same time and were in close proximity to one another (within 10 km) until they parted ways prior to October 16. On October 4 one female (#51874) left Eclipse Sound and a second one (#51875) reached the mouth of the Sound. By

mid-October, all five whales had left Eclipse Sound; three females were moving southeast along Baffin Island and the two males approached Cumberland Sound (#51871 entered on Oct 16, and #51872 entered on October 22nd) (Figure 3; Table 2B). Male #51872 headed out of Cumberland Sound on November 15 and #51871 left on November 27. Male #51871 moved to the deep waters of the Davis Strait and male #51872 headed to the western shores of Greenland in Disko Bay on December 3 (Figure 3; Table 2B). Whale #51872 remained in Disko Bay until January 5. February 10 was the last transmission from #51872 and it was still located in the Davis Strait. By November 9 all three female narwhals had reached Davis Strait, where they wintered until the last transmissions were received from tag #51874 and #51875 on February 26 and January 25, respectively. Female #51873 continued providing location information, and this whale made a return migration along the east coast of Baffin Island and to the north shores of Bylot Island, outside of Eclipse Sound from April 17 to June 28, 2011 (Figure 3). On July 12 this whale moved into Navy Board Inlet but, for some reason, turned back and moved into Admiralty Inlet on July 28, where it remained until the tag finished transmitting on October 10, 2011 (Tables 1 and 2B).

Of the seven narwhals tagged in Eclipse Sound in 2011, three tagged whales (#57590, #39270, and #51879, all females) traveled out of Eclipse Sound through Navy Board Inlet on August 31 and moved into Admiralty Inlet where they remained until September 29, 28 and October 16, respectively (Figure 4; Table 2C). Female #57590 later entered Prince Regent Inlet on September 30 while female #39270 did so on October 1st. Both whales exited north into Lancaster on October 7. The remaining four narwhals (three females and one male) stayed in Eclipse Sound until October 4-13. Also, male #51878 travelled out of Eclipse Sound through Navy Board Inlet on October 4, entered Admiralty Inlet on October 13th and returned to Lancaster Sound by October 19. At this time all six other narwhals were moving southeast along Baffin Island, and one of them, female #51876 was already nearing Clyde River. Between October 31 and November 15 all seven whales moved into deep waters of Davis Strait (Figure 4; Table 2C). At the time of writing, January 2012, four of the female tags were still providing high quality locations and they were still in this area, while male #51878 and females #39315 and #57590 were not providing locations (Tables 1 and 2C).

Overall, narwhals tagged in Eclipse Sound in both years (2010 and 2011) had a remarkably similar timing of autumn migration (Figure 5). All 11 whales left the fiords and inlets of northern Baffin Island in November, and migrated to Davis Strait where they spent the winter (Figure 5). One tag (female #51873) from Eclipse Sound provided information on the spring migration back to the summering region. This whale started moving slowly north on April 17 and entered Admiralty Inlet on July 28. Four male narwhals from Admiralty Inlet (#39256, #39287, #39309, and #39311) provided information on the spring migration and three of these narwhals began directed northward movements on March 27 at which point we lost contact with tag #39256 on June 23 and #39287 on June 2. One whale (#39311) moved back south on April 28 after which the tag finished transmitting (June 3). The last male (#39309) did not begin its northward movements until April 28 before we lost contact with the tag on May 2 (Figure 5). Typically narwhal made these northward movements in the deep waters off the coastal shelf of Baffin Island (Figures 2 and 5).

DISCUSSION

COMPARISON WITH OTHER TAGGED WHALES

There were 51 narwhals tagged from the Admiralty Inlet and Eclipse Sound stocks from 1997-2005 and approximately 90 % of them remained in their putative summer stock range (Table 3). Those that left the range before the end of summer did so in late August or early September. In 1999 three narwhals tagged in Eclipse Sound travelled outside of the Sound and into Admiralty and Prince Regent Inlets during the same period (Heide-Jørgensen et al. 2002), and, a 2005 tracking update report indicated that "a few" narwhals from the Admiralty Inlet stock had made brief visits to Prince Regent Inlet (part of the summer range for the Somerset Island stock) and Eclipse Sound (M.P. Heide-Jørgensen and K. Laidre, unpubl. data) (Table 3). This may indicate some overlap of the Admiralty Inlet, Somerset Island, and Eclipse Sound narwhal stocks but overall site fidelity within a season was quite high for these narwhals in the past. In the present study, most of the narwhals tagged in Admiralty Inlet traveled west to the mouth of Prince Regent Inlet, with over half of the tagged narwhals travelling deeper south into the Inlet. Over 40 % of narwhals tagged in Eclipse Sound travelled west to Admiralty Inlet and two visited the summering range for the Somerset Island stock. The summer movements of Admiralty Inlet and Eclipse Sound narwhals reported here indicate that there was summer range overlap between narwhals from these two stocks and potentially overlap with the Somerset Island stock in late August - September. These range differences may be a result of increased predatory pressure by killer whales, which has been noted in recent years in Admiralty Inlet (Laidre et al. 2006). Further narwhal tracking will be required to determine if these movements are typical of a larger proportion of the Admiralty Inlet and Eclipse Sound stocks.

All previous studies that investigated narwhal movements from the Eclipse Sound, Somerset Island, and Admiralty Inlet stocks have found that narwhals overwintered in Davis Strait and Baffin Bay (Dietz et al. 2001; Heide-Jørgensen et al. 2002, 2003; Dietz et al. 2008; M.P. Heide-Jørgensen and K. Laidre, unpubl. data). Our study found that one narwhal, tagged in Admiralty Inlet, travelled into Prince Regent Inlet, through Fury and Hecla Strait, and spent the winter in northern Foxe Basin.

SITE FIDELITY

One tag in this study lasted over a year and provided information on site fidelity across years for narwhals from Eclipse Sound. A female narwhal tagged in August 2010 in Eclipse Sound, overwintered in the Davis Strait and when she returned north she continued traveling west, past Eclipse Sound and into Admiralty Inlet on July 28, 2011. This female remained in Admiralty Inlet for at least two months until the tag stopped transmitting on October 10, 2011. In 2000 nine narwhals were tagged from the Somerset Island narwhal stock; two of these tags lasted over a year and provided information on annual site fidelity (Heide-Jørgensen et al. 2003). These narwhals returned to the summering area from which they had originated the previous summer, without visiting any other summering aggregation areas (Heide-Jørgensen et al. 2003). With only three tags providing information of narwhal movements back to their summering region it is difficult to make any definitive conclusions regarding annual site fidelity. However, new evidence from this study suggests site fidelity, at least for the Eclipse Sound stock, is not as strong as previously thought. In light of these results, sensitivity analysis was conducted to compare results from the Baffin Bay narwhal landed catch allocation tool (Richard 2011) when Admiralty Inlet and Eclipse Sound narwhals are considered separate stocks versus a single stock (DFO

2012). Further tracking of narwhals from these two stocks is required to determine if the recent movements are typical of a greater proportion of the population and if Admiralty Inlet and Eclipse Sound narwhals should be considered a single stock.

CONCLUSION

Very few tags have provided a full year of coverage that could be used to assess philopatry (return from year to year) to summer aggregation areas in August. More tracking effort would enhance our understanding of the movements and distribution of narwhals from the Admiralty Inlet and Eclipse Sound summer aggregations. Another tagging expedition in Tremblay Sound is tentatively planned for summer 2012. Future tracking efforts are also needed to understand the seasonal range of narwhals that occupy East Baffin Island, Jones Sound, Smith Sound and the Parry Islands, since relatively little is known about where these narwhals travel and migrate in the winter. Continued tracking of narwhals will improve our understanding of how a changing environment could impact narwhal populations and their distribution.

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Table 1. Deployment date, date of last transmission, and total length of transmission period for narwhals deployed with satellite-linked transmitters. Sex and morphometric data are also indicated for each narwhal. "Active" indicates uplinks from the tag were still being received as of February 7, 2012.

Tagging Location	Deployment Date	Last Transmission	Transmit Length (days)	Sex	Tag Number	Length (m)	Fluke Length (m)	Tusk length (m)
Admiralty Inlet	2009-08-15	2010-02-22	200	F	39290	3.74	0.86	-
Admiralty Inlet	2009-08-15	2010-05-02	259	M	39309	3.77	0.86	0.79
Admiralty Inlet	2009-08-16	2010-02-03	171	F	39313	3.91	0.89	-
Admiralty Inlet	2009-08-17	2010-06-03	230	M	39311	3.07	0.76	0.51
Admiralty Inlet	2009-08-17	-	-	M	39312	4.54	1.12	2.11
Admiralty Inlet	2009-08-17	2010-06-23	310	M	39256	4.50	1.07	1.65
Admiralty Inlet	2009-08-17	2010-06-02	289	M	39287	4.39	1.04	1.50
Admiralty Inlet	2009-08-18	2009-12-23	127	F	39249	3.86	0.94	-
Tremblay Sound	2010-08-21	2011-04-28	250	M	51871	4.44	1.07	1.56
Tremblay Sound	2010-08-21	2011-02-10	320	M	51872	4.61	1.03	1.00
Tremblay Sound	2010-08-22	2011-10-10	413	F	51873	4.00	0.90	-
Tremblay Sound	2010-08-22	2011-02-26	187	F	51874	3.90	0.96	-
Tremblay Sound	2010-08-24	2011-01-25	153	F	51875	3.80	0.93	-
Tremblay Sound	2011-08-16	Active		F	51876	3.91	0.85	-
Tremblay Sound	2011-08-16	2011-12-22	129	M	51878	3.10	0.76	0.20
Tremblay Sound	2011-08-16	Active		F	51879	4.01	0.91	-
Tremblay Sound	2011-08-18	Active		F	39314	4.06	0.93	-
Tremblay Sound	2011-08-18	Active		F	39270	3.94	0.97	-
Tremblay Sound	2011-08-19	2011-12-22	126	F	39315	3.89	0.95	-
Tremblay Sound	2011-08-19	2012-01-16	151	F	57590	4.04	1.04	-

Table 2. Location of each tagged whale by month for narwhals tagged in (A) Admiralty Inlet in 2009, (B) Eclipse Sound in 2010, and (C) Eclipse Sound in 2011. (AI = Admiralty Inlet, PRI = Prince Regent Inlet, LS = Lancaster Sound, DS = Davis Strait, NFB = northern Foxe Basin, ES = Eclipse Sound, CS = Cumberland Sound, DB = Disko Bay, NBI = northern Bylot Island).

A Tag	39290	39309	39313	39311	39256	39287	39249
Deployment date	2009-08-15	2009-08-15	2009-08-16	2009-08-17	2009-08-17	2009-08-17	2009-08-18
Aug	AI	AI	AI	AI	AI	AI	AI
Sept	PRI	PRI	PRI	AI	LS	Mouth of PRI	PRI
Oct	PRI	LS	LS	DS	DS	DS	LS
Nov	NFB	DS	DS	DS	DS	DS	DS
Dec	NFB	DS	DS	DS	DS	DS	DS
Jan	NFB	DS	DS	DS	DS	DS	
Feb	NFB	DS	DS	DS	DS	DS	
March		DS		DS	DS	DS	
Apr		DS		DS	DS	DS	
May		DS		DS	DS	DS	
June				DS	DS	DS	
Final Transmission	2010-02-22	2010-05-02	2010-02-03	2010-06-03	2010-06-23	2010-06-02	2009-12-23

Table 2 continued. Location of each tagged whale by month for narwhals tagged in (A) Admiralty Inlet in 2009, (B) Eclipse Sound in 2010, and (C) Eclipse Sound in 2011. (AI = Admiralty Inlet, PRI = Prince Regent Inlet, LS = Lancaster Sound, DS = Davis Strait, NFB = northern Foxe Basin, ES = Eclipse Sound, CS = Cumberland Sound, DB = Disko Bay, NBI = northern Bylot Island).

B Tag	51871	51872	51873	51874	51875
Deployment date	2010-08-21	2010-08-21	2010-08-22	2010-08-22	2010-08-24
Aug	ES	ES	ES	ES	ES
Sept	DS	DS	ES	ES	ES
Oct	CS	CS	DS	DS	DS
Nov	DS	DS	DS	DS	DS
Dec	DS	DB	DS	DS	DS
Jan	DS	DS	DS	DS	DS
Feb	DS	DS	DS	DS	
March	DS		DS		
Apr	DS		DS		
May			DS		
June			DS		
July			NBI/AI		
Aug			AI		
Sept			AI		
Oct			AI		
Final Transmission	2011-04-28	2011-02-10	2011-10-10	2011-02-26	2011-01-25

C Tag	51876	51878	51879	39314	39270	39315	57590
Deployment date	2011-08-16	2011-08-16	2011-08-16	2011-08-18	2011-08-18	2011-08-19	2011-08-19
Aug	ES	ES	ES	ES	ES	ES	ES
Sept	ES	ES	AI	LS	AI	DS	AI
Oct	DS	Mouth of AI	AI	DS	PRI	DS	PRI
Nov	DS	DS	DS	DS	DS	DS	DS
Dec	DS	DS	DS	DS	DS	DS	DS
Final Transmission	Active	2011-12-22	Active	Active	Active	2011-12-22	2012-01-16

Table 3. Review of all tagged narwhals from Eclipse Sound, Somerset Island, and Admiralty Inlet stocks (ES=Eclipse Sound, SI=Somerset Island, AI=Admiralty Inlet, NHB = Northern Hudson Bay).

Tag Year	Tagging Location	# Tags Deployed	Sex ratio (F: M)	# Moved to other stock areas	Other stock area travelled to	Tags lasting over a year	Source
1997	ES	5	1: 4	0		0	Dietz et al. 2001
1998	ES	5	2: 3	0		0	Dietz et al. 2001
1999	ES	7	5: 2	3	AI and SI	0	Heide-Jørgensen et al. 2002
2000	SI	9	9: 0	0		2	Heide-Jørgensen et al. 2003
2001	SI	7	7: 0	0		0	Heide-Jørgensen et al. 2003
2003	AI	13	5: 8	0		0	Dietz et al. 2008
2004	AI	8	5: 3	0		0	Dietz et al. 2008
2005	AI	13	11: 2	"a few"	ES and SI	0	M.P. Heide-Jørgensen and K. Laidre, unpubl. data
2009	AI	7	3: 4	4	SI	0	
2010	ES	5	3: 2	1	AI	1	
2011	ES	7	6: 1	4	AI and maybe SI	-	

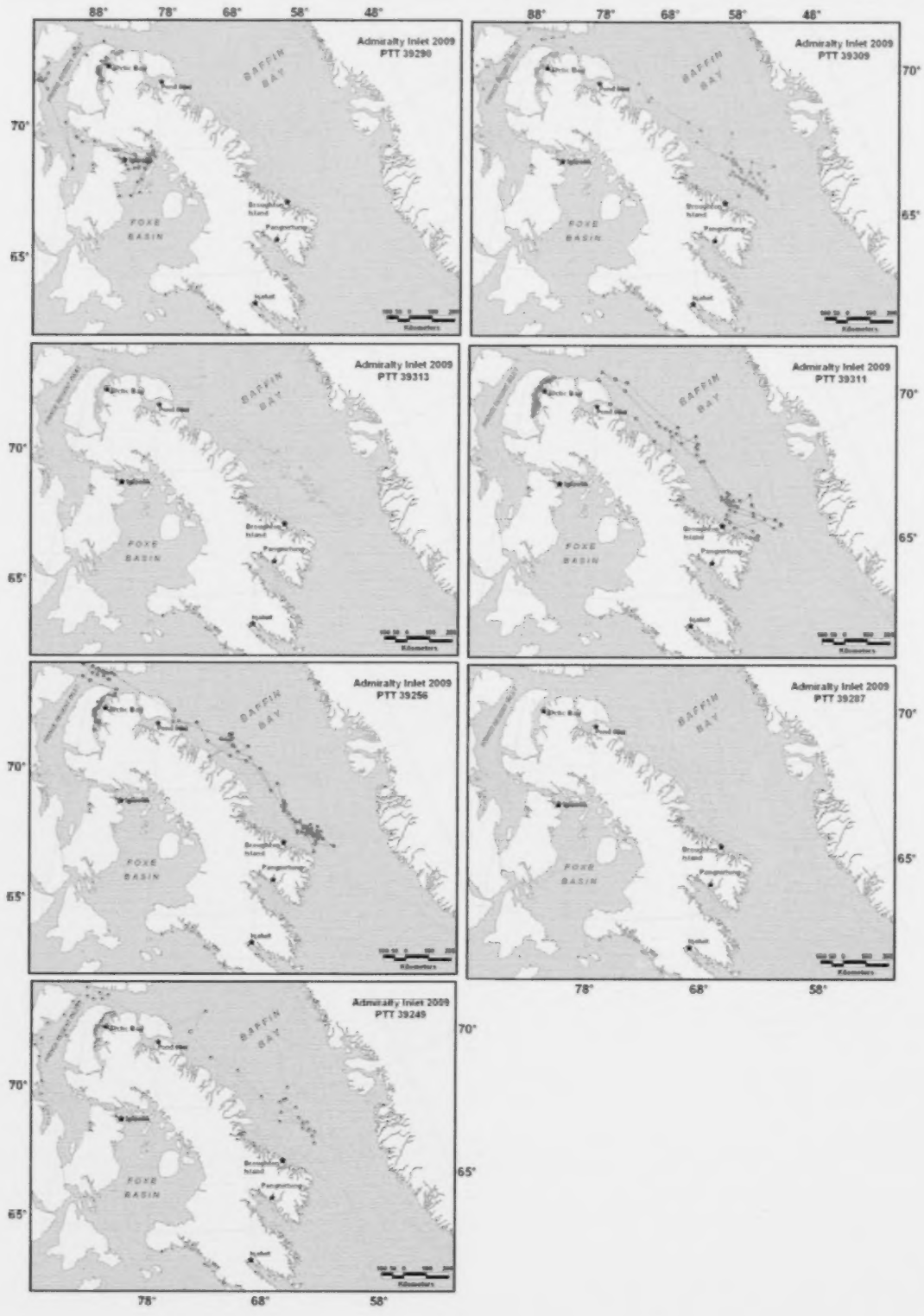

Figure 1. Track lines from seven whales tagged in 2009 in Admiralty Inlet. Tracks indicate movement of the whale for the duration of the tag.

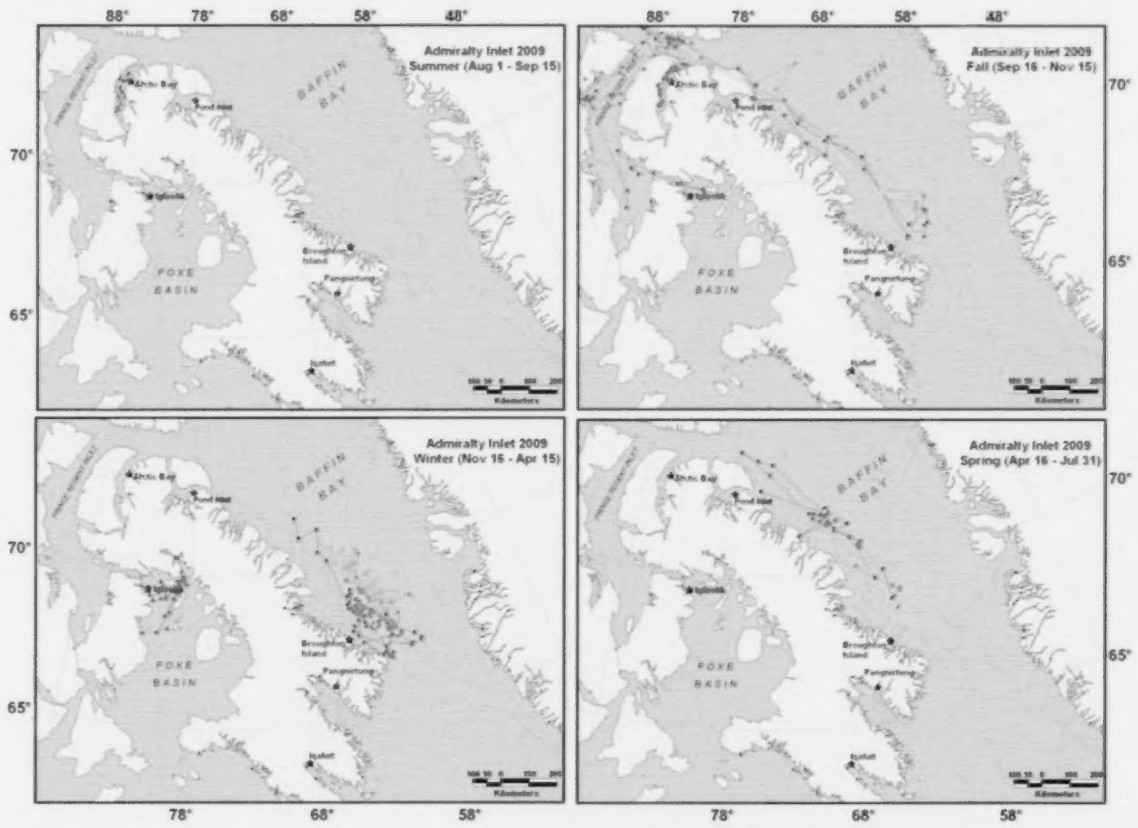

Figure 2. Track lines from seven whales tagged in 2009 in Admiralty Inlet divided by season.

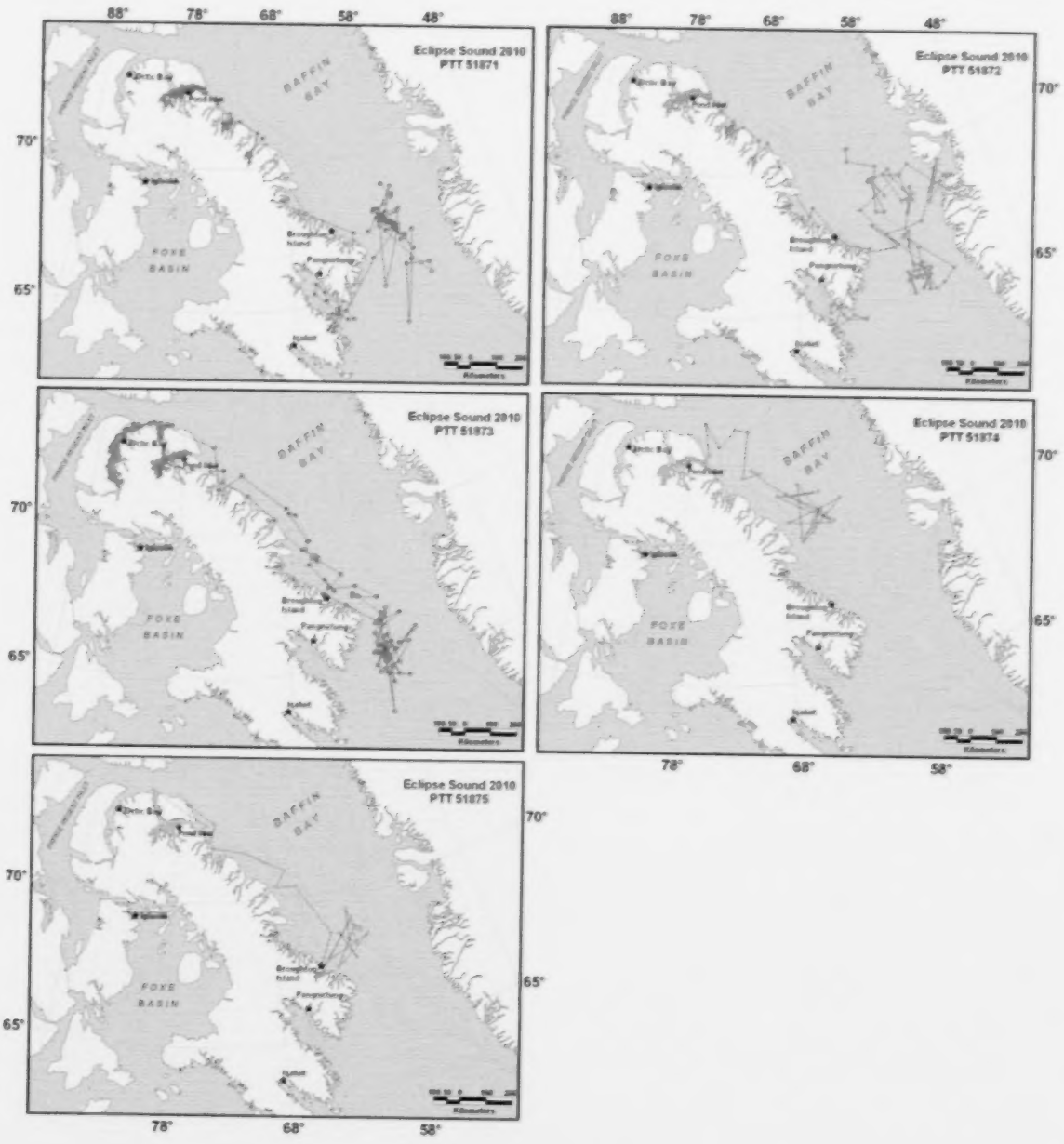

Figure 3. Track lines from five whales tagged in 2010 in Eclipse Sound.

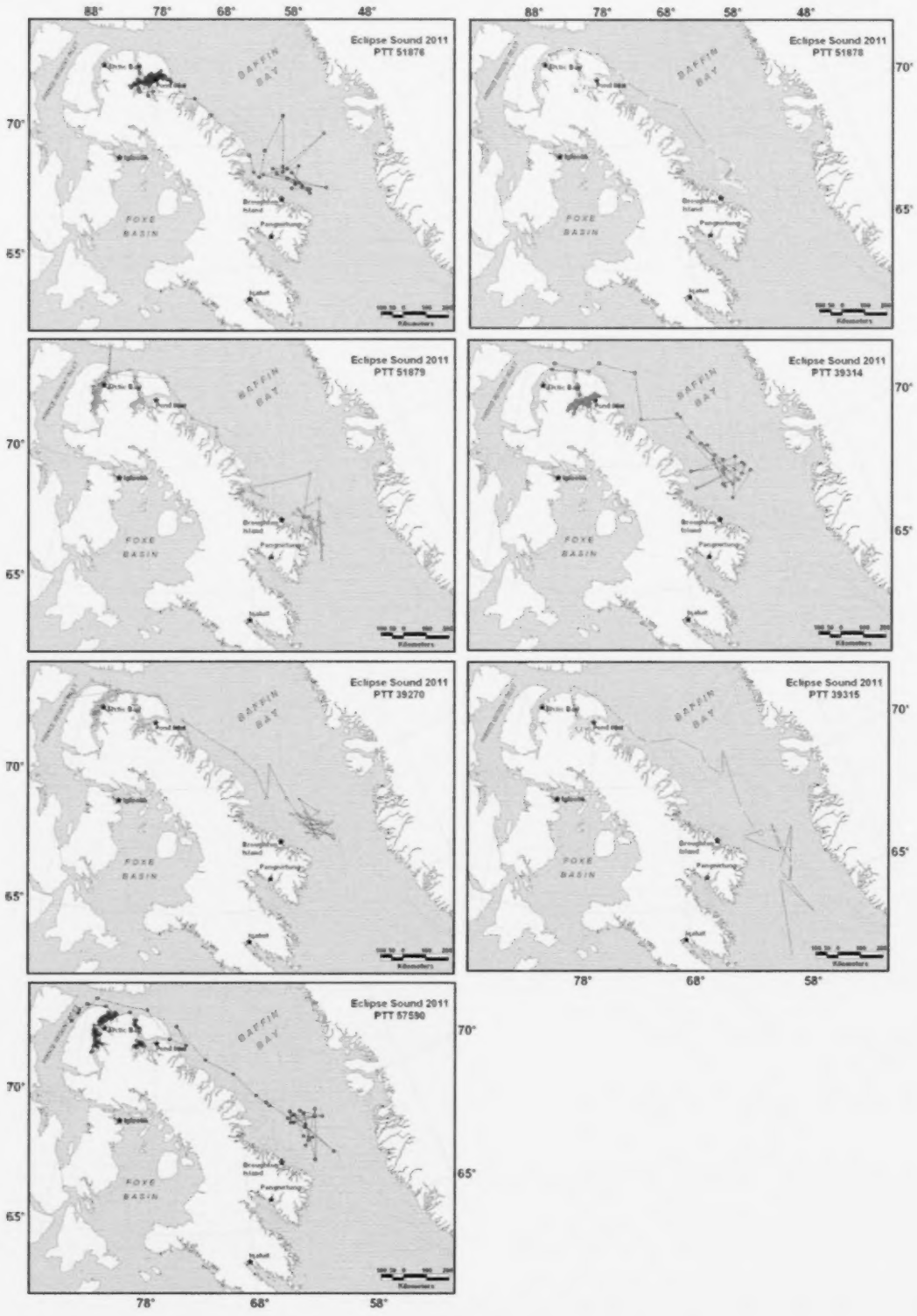

Figure 4. Track lines from seven whales tagged in 2011 in Eclipse Sound.

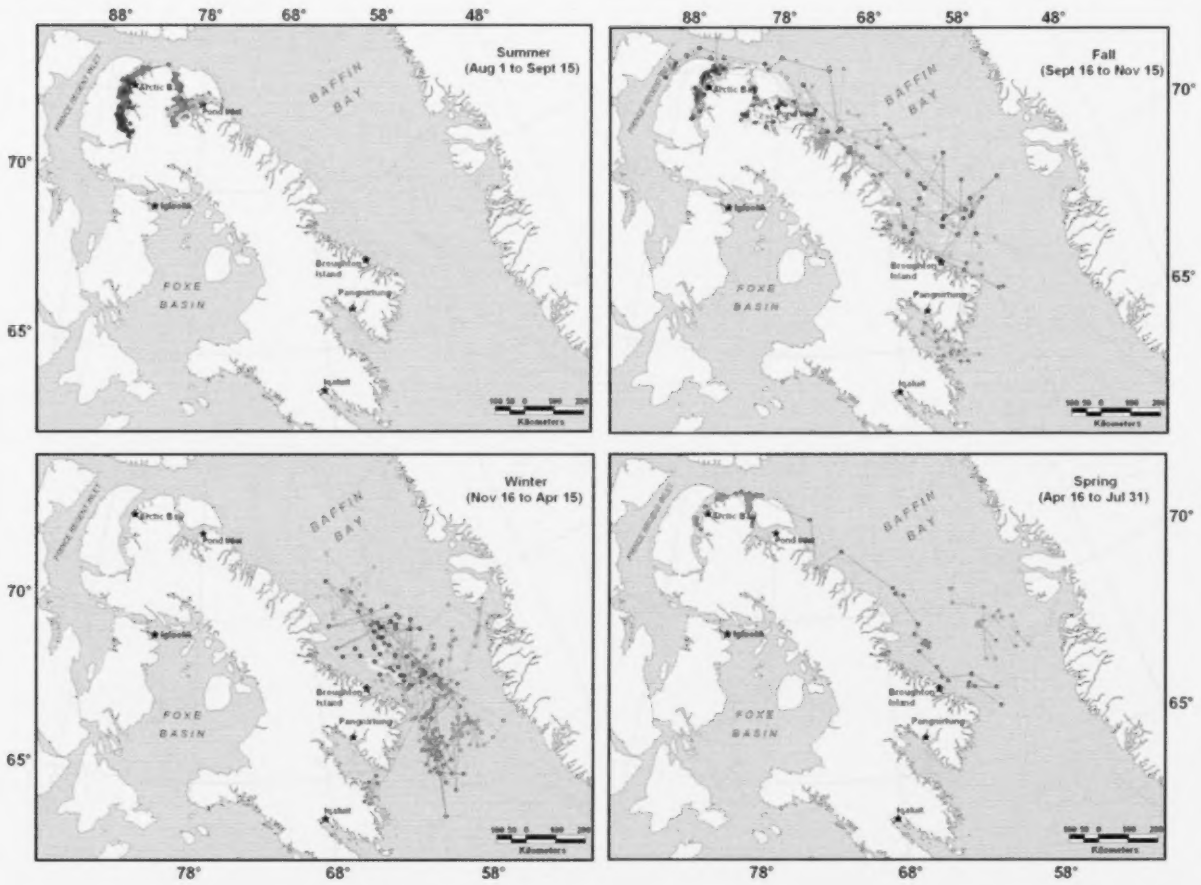

Figure 5. Track lines from twelve whales tagged in 2010 and 2011 in Eclipse Sound divided by season.

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